

WE CLAIM:

1. A self-joining polymer composition, comprising:
  - 5 a polymer;
  - a plurality of amine pendant groups attached to the polymer; and
  - a plurality of microcapsules of flowable polymerizable material dispersed in the polymer, the microcapsules of flowable polymerizable material including microcapsules and flowable polymerizable material inside the
  - 10 microcapsules, the microcapsules effective for rupturing with a failure of the polymer and the flowable polymerizable material cross-linking with the reactable pendant groups upon rupture of the microcapsules.
2. The self-joining polymer composition of claim 1, wherein the  
15 plurality of reactable pendant groups are attached to a backbone of the polymer.
3. The self-joining polymer composition of claim 1, wherein the failure of the polymer comprises a crack having a first face and a second face, whereby the first face and the second face are opposing faces, wherein a first portion of  
20 reactable pendant groups is on the first face and a second portion of the plurality of reactable pendant groups is on the second face of the crack and wherein cross-links are formed between the first portion and the second portion of the plurality of reactable pendant groups creating cross-linking between the opposing faces of the crack.
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4. The self-joining polymer composition of claim 1, wherein the microcapsule comprises a shell defining an interior space with the flowable polymerizable material disposed therein.

5. The self-joining polymer composition of claim 4, wherein the microcapsule shell comprises a material selected from the group consisting of hydrous metal oxide, silica, silicate, carbon, polymer, and combinations thereof.

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6. The self-joining polymer composition of claim 1, wherein the flowable polymerizable material is selected from the group consisting of short and long chain dianhydrides and combinations thereof.

10 7. The self-joining polymer composition of claim 1, wherein the polymer is selected from the group consisting of epoxies, thermoset, thermoplastic, elastomeric, and combinations thereof.

15 8. A method for healing a failure in a composite member, the method comprising:

providing a composite member comprising a polymer, a plurality of reactable pendant groups attached to the polymer, and a plurality of microcapsules containing a flowable polymerizing agent dispersed throughout the polymer;

20 rupturing at least one of the plurality of microcapsules responsive to a failure in a region of the composite member;

releasing the flowable polymerizing agent responsive to the rupture; cross-linking the flowable polymerizing agent with the plurality of reactable pendant groups in the failure region.

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9. The method of claim 8, wherein cross-linking the flowable polymerizing agent with the plurality of reactable pendant groups in the failure region comprises:

5 chemically bonding a first end of at least one flowable polymerizing agent molecule to a reactable pendant group on a first face of the failure;

chemically bonding a second end of the at least one flowable polymerizing agent molecule to a reactable pendant group on a second face of the failure, wherein the at least one bonded flowable polymerizing molecule

10 prevents the failure from propagating within the composite member.

10. An article of manufacture comprising a self-joining polymer composition, the self-joining polymer composition comprising:

15 a polymer;

a plurality of reactable pendant groups attached to the polymer; and

a plurality of microcapsules containing a flowable polymerizable material dispersed in the polymer, the microcapsules effective for rupturing with a failure of the polymer wherein the flowable polymerizable material cross-links with the reactable pendant groups to join the failure.

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11. The article of manufacture of claim 10, wherein the plurality of reactable pendant groups are attached to a backbone of the polymer.

12. The article of manufacture of claim 10, wherein the failure of the

25 polymer comprises a crack having a first face and a second face, whereby the first face and the second face are opposing faces, wherein a first portion of reactable pendant groups is on the first face and a second portion of the plurality of reactable pendant groups is on the second face of the crack and wherein cross-links are formed between the first portion and the second portion of the

30 plurality of reactable pendant groups creating cross-linking between the opposing faces of the crack.

13. The article of manufacture of claim 10, wherein the article of manufacture is selected from the group consisting of aero-nautical structures, automotive parts, sporting equipment, construction material, electronic packages, 5 electronic encapsulants, electronic die attach, plastic packaging, structural composites, display lenses/windows, flotation devices, pneumatic tire parts, adhesives, paints, sealants, impregnating resins, finishes, coatings, and parts and combinations thereof.

10 14. The article of manufacture of claim 10, wherein the flowable polymerizable material is selected from the group consisting of short and long chain dianhydrides and combinations thereof.

15 16. The article of manufacture of claim 10, wherein the polymer is selected from the group consisting of epoxies, thermoset, thermoplastic, elastomeric, and combinations thereof.

20 16. An electronic package comprising:  
a printed circuit board;  
a semiconductor device attached to the printed circuit board by an adhesive; and  
an encapsulant covering the semiconductor device and at least a portion of the printed circuit board,  
at least one of the adhesive or encapsulant including a self-joining 25 polymer composition, wherein the self-joining polymer comprises:  
a polymer having a plurality of reactable pendant groups; and  
a plurality of microcapsules containing a flowable polymerizable material dispersed in the polymer, the microcapsules effective for rupturing with a failure of the polymer wherein the polymerizable material cross-links with the 30 reactable pendant groups to join the failure.

17 The electronic package of claim 16, wherein the plurality of reactable pendant groups are attached to a backbone of the polymer.

5 18. The electronic package of claim 16, wherein the failure of the polymer comprises a crack having a first face and a second face, whereby the first face and the second face are opposing faces, wherein a first portion of reactable pendant groups is on the first face and a second portion of the plurality of reactable pendant groups is on the second face of the crack and wherein  
10 cross-links are formed between the first portion and the second portion of the plurality of reactable pendant groups creating cross-linking between the opposing faces of the crack.

19. A printed circuit board comprising a metal circuit pattern disposed  
15 on a board that includes a plurality of layers of fiber reinforced resin, wherein the resin includes a self-joining polymer composition comprising:  
a polymer;  
a plurality of reactable pendant groups attached to the polymer; and  
a plurality of microcapsules containing a flowable polymerizable  
20 material dispersed in the polymer, the microcapsules effective for rupturing with a failure of the polymer wherein the polymerizable material cross-links with the reactable pendant groups to join the failure.

20. The printed circuit board of claim 19, wherein the flowable  
25 polymerizable material is selected from the group consisting of short and long chain dianhydrides and combinations thereof.

21. The printed circuit board of claim 19, wherein the plurality of reactable pendant groups are attached to a backbone of the polymer.

22. The printed circuit board of claim 19, wherein the failure of the polymer comprises a crack having a first face and a second face, whereby the first face and the second face are opposing faces, wherein a first portion of 5 reactable pendant groups is on the first face and a second portion of the plurality of reactable pendant groups is on the second face of the crack and wherein cross-links are formed between the first portion and the second portion of the plurality of reactable pendant groups creating cross-linking between the opposing faces of the crack.

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